

**SOUTHERN PACIFIC LINES**

**RULES AND INFORMATION**

**FOR THE HANDLING OF**

**OIL BURNING LOCOMOTIVES**

JUNE 1, 1928



No 14657

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## DEFINITION OF TERMS

**Atomizer:**—That portion of burner which delivers steam used for carrying and breaking up oil into small particles to aid combustion.

**Black Smoke:**—Carbon from partially consumed oil. A sign of imperfect combustion and improper handling of firing device.

**Brick Work:**—Fire brick used in lining firebox and draft pan to protect mud ring, firebox, fire pan and fire door.

**Burner:**—A device for atomizing and delivering oil to the firebox.

**Carbon:**—A grayish black substance forming on the floor or flash wall. Generally formed by some foreign substance, broken brick, tool or waste being left on floor of fire pan, by improper alignment of burner, or by air leaks in fire pan.

**Damper:**—A metal cover used over the air intake to the fire pan to regulate the amount of air admitted to firebox.

**Fire Door:**—An opening in back head of boiler through which workmen may enter firebox for inspection and repairs.

**Fire Lighter:**—Consists of a piece of netting formed in any convenient shape to hold a piece of waste saturated with oil. This netting is attached to a light rod of sufficient length to reach burner.

**Firing Valve:**—A device for regulating the flow of oil to burner.

**Flash Wall:**—An arrangement of fire-brick in the fire pan toward which fuel oil is delivered and which assists in ignition of the oil and deflects the course of the flame.



**Heater:**—A pipe controlled by a valve through which steam passes to heat the oil.

**Manhole:**—The openings in the oil and water tanks on tender.

**Measuring Rod:**—A steel rod for measuring the amount of fuel oil in tank.

**Oil Tank Valve:**—A device in oil tank for shutting off flow of oil to burner.

**Peep Hole:**—A small circular hole in fire door sometimes called sand hole.

**Sand Scoop:**—A scoop used for delivering sand through peep hole in fire door to remove soot from flues.

### Instructions relative to the duties of locomotive firemen.

#### BEFORE LEAVING INITIAL STATION

1. Register name on roundhouse register in proper place, showing amount of rest had previous to being called. Examine bulletin board.

2. Upon entering the cab of locomotive for departure of a trip, first ascertain amount of water in the boiler by trying water gauge cocks, also note water level in water glasses. If there is no indication of water, immediately put out the fire, and in no case attempt to put water in the boiler before consulting the engineman. If water shows in gauges, to determine the true level open water glass cocks, open drain cock to water glasses to clear glasses out, and see if circulation is free; then close drain cock. Then compare with engineman to determine if registering correctly.

3. Examine firebox for any foreign matter, condition of brick work and burner, and note if flues are free from leaks.

4. See that the following supplies are on locomotive: (Habit should be formed of checking them in the same order each trip and the absence of any supplies will then be more quickly noted) 2 red flags, 2 green flags, 2 white flags; 6 red fuses; at least 12 torpedoes; red and white lantern; **indicator stencils** and "dash" stencils—blank stencils; waste; valve oil can; engine oil can; compound for boiler (if used) and bucket for mixing same; engineman's tool box, oilers and torches. If supplies or equipment are missing, inform the engineman.

5. If called during the night or shortly before sundown, light both lanterns, and display a red lantern on rear of tank while moving from round house to train.

6. Before starting trip see that water tank is full and that there is sufficient fuel oil in tank. Report amount to engineman. Avoid waste of fuel and water at all times. See that sand box is full of sand and contains scoop. Also, see that steam turret valves, both boiler check valves, and both water tank valves are wide open.

7. In blowing out boilers, blow off cock should be opened five seconds then closed for a similar period, this to be repeated until satisfied that boiler has been blown sufficiently. For best results, boiler should be blown out when standing or with throttle closed, and injector or water pump must not be working.

8. When locomotive is placed on train and your **identification is positively known**, place numbers in indicators, and if necessary, flags of proper color and at night in addition, lights of the same color and from the ground look at each indicator and determine if num-

bers are correct. Five minutes after lighting classification lights look at them to see if they are burning.

9. When engineman finishes oiling, fill the oilers, and if in winter, place in a position where they will keep warm.

10. Compare watch with engineman.

#### DUTIES ON ROAD

11. Fireman must report to and receive instructions from his engineman.

12. When displaying green or white signal lights and markers as per rules 19, 20, and 21 of the Rules and Regulations of the Transportation Department, notice them at frequent intervals to see if both lights are burning properly; if not, notify your engineman at once and comply with the rules.

13. After taking water don't fail to place spout to insure proper clearance for other trains.

14. Read train orders after engineman has read them. Observe block signals and track. Fireman should frequently look back on curves along train for hot boxes, stuck brakes, etc.

15. Be sure to look at indicators and classification lights and indicators on caboose as well as markers on passing trains and repeat the identification to engineman.

16. Form the habit of looking at your watch passing train-order signals, and after getting into clear for other trains.

17. In preparing boiler compound, use 1/4-lb. per 1000 gallons water and dissolve thoroughly in a bucket with hot water taken from the squirt hose. When mixing compound with hot water stir well so it will be thoroughly dissolved. Be sure all cold water is

drained from squirt hose before mixing with the compound as cold water will not dissolve the compound thoroughly. After compound is thoroughly dissolved, pour contents of bucket into locomotive water tank before taking water.

18. Where locomotives continue on train through terminals, and crew is relieved, firemen will see that long spout engine oil cans are filled before arrival at such terminals.

19. Fireman must keep bell oiled and tell engineman of any work coming to his notice that should be reported.

#### ON ARRIVING AT TERMINAL

20. Take down flags, put out classification lights, remove numbers from indicators and replace in box provided. Flags should be neatly rolled up and placed in box provided.

21. On arriving at terminal, if at night, hang a red lantern on rear of tank before locomotive is cut off and remove same when locomotive is placed on roundhouse lead. When locomotive stops on roundhouse lead see that boiler has a full glass of water. Report to engineman amount of fuel oil in tank.

22. Examine firebox to determine condition of brick work and flues and report to engineman.

23. On arrival at roundhouse register information required and be sure caller knows where to locate you.

#### STARTING THE FIRE

24. Start the fire in a locomotive as follows:

See that the locomotive is securely blocked. Have two gauges of water in the boiler, determining the water level by use of the gauge cocks. Note condition of water glasses.



Remove carbon, fire brick or other obstructions that would interfere with the flame from the burner to opposite end of firebox. Open the damper.

Insure flow of oil to burner by heating oil in tank to proper temperature and by mild circulation of steam through engine oil heater.

Open the blower valve enough to create a light draft through the firebox.

Blow out any condensation that may be in the steam pipe or steam passage of burner by opening the atomizer valve for a few seconds.

Open the oil tank valve.

Apply the fire lighter in the firebox and stand to left side of fire door.

Open atomizer valve enough so that when the oil begins to flow the steam current will be sufficient to carry the oil to the fire. Open firing valve carefully to avoid a heavy explosion when the oil ignites using only enough oil to generate steam without making black smoke. It is imperative that the atomizer be opened first, then open the firing valve gradually.

Observation may be made through fire door, but guard against the out-flash of flame that may follow the ignition.

In firing up a locomotive the fire may, from some cause, go out; watch it closely until boiler is hot. If fire goes out, it must be re-lighted by applying the fire lighter. Lighting it from heated bricks causes an explosion which may result in personal injury and damage the brickwork.

When starting fire, in a locomotive having steam in the boiler, that has been extinguished from any cause, see that the blower is on enough to draw the gases from the fire box and flues, as neglect of this precaution may cause an explosion.

When firing up a locomotive not under steam, the engine house steam line should be connected and used to supply steam for both the blower and the atomizer of the locomotive. After the boiler has accumulated forty pounds pressure of steam the engine house steam line should be disconnected and steam supplied from the locomotive boiler.

Wood should be used in starting the fire when steam pressure is not available to work the atomizer and blower. Be careful when putting the wood in the firebox not to damage the brick work or burner.

Carefully adjust the atomizer and the firing valve so that the oil will be atomized and consumed as it passes from the burner. Careless adjustment may cause part of the flow of oil to drip down from the burner and be wasted, or by dropping into the pit may cause damage by fire or explosion.

Before starting the locomotive, all wood must be completely burned or removed from the firebox to avoid danger of setting fire to adjacent buildings or inflammable material. Sparks from burning wood will readily go through the flues and stack when locomotive is working.

#### ADJUSTMENT OF BURNER

25. The burner must be adjusted so that the atomized oil will strike the flash wall.

The burning oil must pass across the firebox parallel with the side sheets and the floor of the firebox. It should strike the center of the flash wall.

Should it strike toward one side, that side of the firebox only will be filled with flame, thereby adversely affecting the steaming of the locomotive.

If the oil should strike some obstruction

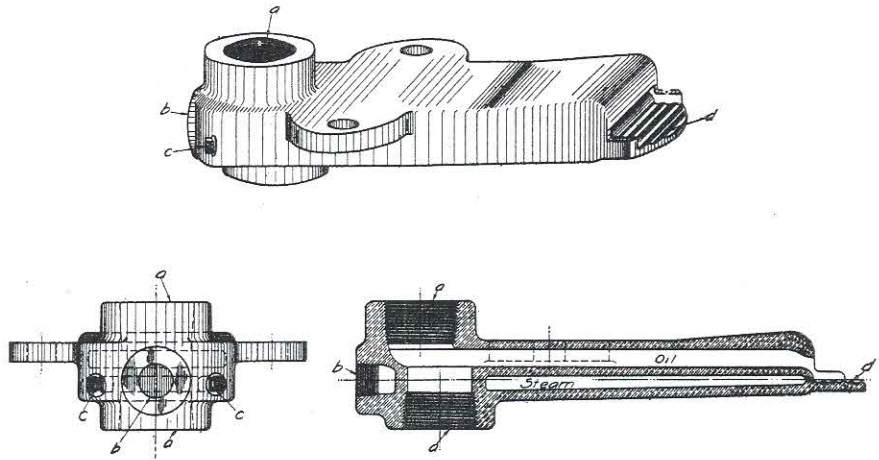


Fig. 1

before reaching the flash wall, it may result in poor steaming of locomotive and cause black smoke and carbon.

The oil and steam ports at mouth of burner must be kept open, and the openings should be uniform throughout their length. If open at one side more than the other, a larger quantity of steam or oil will be drawn from that side. The upper and lower lips of the atomizer port must be even. If there is a slight extension of one beyond the other, it will direct flame upward or downward. Sand holes in partition wall between steam and oil cavities of burner will cause irregular flow of oil. Burner should be tested for these defects before being applied.

Burner should be carefully inspected and adjusted before the locomotive leaves the roundhouse in order to insure a free steaming locomotive and an economical combustion of fuel. If for any cause the burner should get out of order or out of position while on the road, the engineman should adjust, and report it upon arrival at the terminal.

#### INSUFFICIENT FLOW OF OIL TO THE BURNER

26. If the flow of oil to burner is not sufficient for operation desired, it may be due to:  
Low temperature of the oil.  
Low oil supply in tender tank.  
The burner or piping being clogged.

#### HOW TO "BLOW OUT" BURNER AND OIL PIPES

27. To blow out the burner:  
Close the tank oil valve (on tender).  
Open blower to create draft through fire-box. Open the firing valve gradually until full open. Stand to left side of fire door then slightly open the blow-back valve.



The steam will then pass through the blow-back valve into and through the oil feed pipe and oil opening of the burner, slowly blowing out any oil that remains in the feed pipe. When this is accomplished open wide the blow-back valve for a short time to allow the full steam pressure to blow through the oil passage of the burner. Then close the blow-back and the firing valve.

To blow back the oil feed pipe passage into the oil tank:

Close firing valve.

Open oil tank valve (on tender).

Open blow-back valve.

Allow steam to blow back through blow-back valve into the oil tank, driving with it any obstruction that may be in the feed pipe or on the seat of the oil valve. Then:

Close engine oil heater valve.

Close oil tank valve.

Close blow-back valve.

Except when "blowing out" the oil pipes or the burner, the **blow-back valve must be kept closed.**

If the blow-back valve is left open or if it is leaking, steam will pass into the oil pipe with the oil causing an intermittent flow of oil to the burner, accompanied with black smoke and possible explosions.

#### TEMPERATURE OF OIL IN TANK

28. It is important that the oil in the tank be at proper temperature. If oil is too cold, it will not flow freely to the burner, will not atomize properly and the exhaust will have a greater effect on the fire than it should. Overheating the oil makes it difficult to regulate the fire at the burner.

The oil gases make the flow to the burner irregular.

This results in the fire fluctuating and wastes fuel, because a good portion of the gas from the burner escapes unburned. This condition makes it difficult to carry a light fire when drifting or standing. The remedy is to shut off the tank heater and engine oil heater and to take cold oil in the tank at the first opportunity. A bad effect of overheating the oil is that the asphaltum separates from the lighter oils and settles at the bottom and the lighter oil is driven off as vapor.

The temperature to which the oil should be heated depends on its viscosity. Ordinary oils used should not be heated over 140 degrees F. Heavy oils must be heated higher. Good practice for judging the temperature of the oil is to place the back of the hand on the outside of the tank near the oil outlet. If oil is too hot it will be uncomfortable to back of hand. When possible the oil in the tank should be heated when the locomotive is standing. When the heating is done by direct use of steam the heater valve should be opened wide and left on until the oil is of the proper temperature. It should then be entirely shut off and not used again until necessary. It is bad practice to crack heater valve and leave on continuously. Heat the oil and then shut it off. Apply heater at different intervals to keep the asphaltum body well mixed with the lighter oils. At times it will be noticed that the oil in the pipes between the tender oil tank and the burner becomes so cold that it flows too slowly through the burner. This condition may be overcome by early and proper use of the engine oil heater. The oil in the tank may also be heated by opening the blow-back valve and closing oil feed cock.



## WATER IN OIL

29. Water may accumulate in the oil by improper handling of the heater valve.

When the locomotive is standing or drifting, this water settles toward the outlet, gets into the oil pipe, passes to the burner and puts out the fire. Water in the oil also produces intermittent flashes or kicking of the fire and at times the fire will die down entirely and then flash up as the water disappears and oil reaches the burner. Water in the oil produces a very dangerous condition.

It is very important that water shall not be allowed to accumulate in the oil tank, as the spasmodic fire which results will not only cause steam pressure to drop, but there is great danger of making the flues leak.

## EXPANSION OF FUEL OIL

30. Heating the oil increases the volume and decreases the specific gravity and weight per gallon through expansion of the oil. Decreasing the temperature decreases the volume of the oil and increases the gravity and weight per gallon. The oil changes about one per cent in volume for each 25 degrees change of temperature. In other words, 1,000 gallons of oil at 60 degrees F. will increase ten gallons, or to 1,010 gallons if raised to 85 degrees F. and to 1,020 gallons if raised to 110 degrees F.; that is to say, 1,000 gallons of oil will change 10 gallons in volume for each 25 degrees change in temperature.

## THE ENGINE OIL HEATER

(Figure No. 2).

31. The engine oil heater is described as follows:

The heater casing or chest (1) constructed of tubing of proper strength to sustain

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boiler pressure, having ends closed by heads which are in the form of reducer sockets (2-2).

In the outer ends, through bushings (3-3) is fitted an oil supply pipe (4), forming a portion of the conduit through which oil is fed from the supply tank to burner. All steam and oil joints are made tight and piping securely fastened by screwing up cap (5) so that it abuts against outer end of bushing (3). The heater is placed between the oil feed cock (6) and burner. The front end of the casing (1) is provided with a drain (8), the purpose of which is to drain the condensation and permit circulation of the steam in the heater casing; connection (7) is made for the steam supply pipe, through which steam is admitted to the heater casing. The blow-back pipe (9) is connected with check valve (10) directly into the outer end of T fitting (11) on oil supply pipe between the oil feed cock and the oil tank supply pipe connection. The check valve (10) allows steam to enter through oil pipe but prevents oil passing back into blow-back pipe. A direct blast through oil supply pipe can be obtained by opening valve (4), Figures 6 and 7, which will clean out all obstructions.

In the operation of engine oil heater, steam is admitted by opening valve (7), Figures 6 and 7. Steam passes into engine heater casing (1), Figure 2, through connection (7) and around oil supply pipe (4), heating the oil and escaping through drain (8). The valve controlling the flow of steam to heater is called the engine oil heater valve. This valve should be opened sufficiently to allow a light flow of steam through the heater casing, as the opening of the heater valve to its full capacity accumulates high pressure steam in

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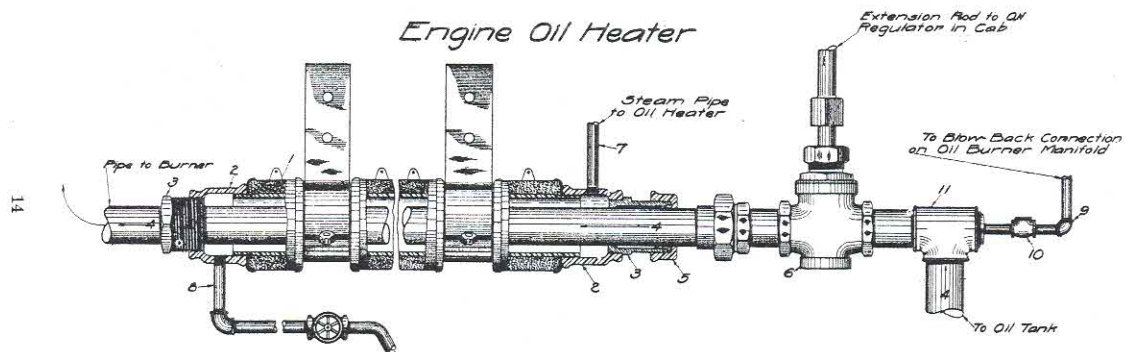


Fig. 2

the heater casing and results in gasifying the oil, causing intermittent flow to burner.

When necessary the blow-back valve (4), Figures 6 and 7, may be used to heat the inside of the oil supply pipe (4), Figure 2, by closing the oil tank valve and opening the firing valve and allowing steam to pass through blow-back valve in cab gradually. The firing valve and blow-back valve should always be closed before opening the oil tank valve.

### THE ATOMIZER

32. The atomizer is used to spray the oil into small particles by the use of a jet of steam so that it may be more easily vaporized and ignited, also to carry the oil against the flash wall with force sufficient to diverge particles in all directions to effect a condition that will completely fill the firebox with flame.

When the atomized oil strikes the flash wall, the continued driving force assists in further separating it, which, from the effect of the heat present, quickly evolves into inflammable vapors that are thrown off in all directions to burn as they mix with the air being admitted.

After closing throttle and cutting down firing valve, cut down the atomizer correspondingly. A slight change in the adjustment of atomizer sometimes produces good results when locomotive is not steaming well; that must be left to the judgment of enginemen.

Bear in mind that the proper adjustment of the atomizer valve is to use the least amount of steam required to fill the firebox with flame. If this effect can not be produced, determine if the burner is partially stopped up, or out of alignment, or if there is some obstruction in the direct line of the oil flow, or if the flash wall is intact.



If too much atomizer is used with a little fire, it will create a disagreeable gas and will cause the fire to burn with a series of light explosions.

### THE BLOWER

33. It is usually advisable to open the blower when the throttle has been shut off, but when blower is used, it should be worked as lightly as requirements will permit. When the locomotive is standing, if a greater fire is desired, the blower may be partly opened to give a better draft. The use of the blower increases the draft through the firebox, the additional air bringing in a greater supply of oxygen. Bring the firebox temperature up as gradually as conditions will permit.

### THE DAMPERS

34. The dampers must be regulated to suit the conditions under which the locomotive is working. When the locomotive is standing or drifting, fire pan damper must be regulated to prevent excessive cold air being drawn into the firebox, to avoid possible damage to the firebox, sheets and flues. When the locomotive is working, the dampers should be regulated to give proper admission of air to the fire for proper combustion.

### SMOKE ABATEMENT

35. Improper adjustment of the firing apparatus is usually indicated by the appearance of black smoke at the stack. Black smoke emitted denotes that part of the carbon has not burned. It would have burned while in the firebox had it come in contact with oxygen. Slightly closing the firing valve will reduce the flow of oil through the burner. Slight use of blower will bring additional oxygen to firebox, burn the free carbon gas,

and black smoke will then disappear. If a locomotive will not steam with a slight color at the stack, a further supply of oil will be a detriment, as soot will accumulate in the flues and cause a greater reduction in steam pressure. Black smoke may be caused by faulty brick work, or improper handling of the firing apparatus. An accurate combination of oil and steam in the atomizer, with proper admission of air, is necessary to produce thorough combustion. The accumulation of carbon in fire box and soot in flues is due to improper combustion. In passing through the flues, the particles of soot come in contact with and adhere to the inside surface of the flues. Soot is a non-conductor of heat. A sufficient quantity deposited on the flues will make a locomotive fail in steaming qualities. Black smoke should be avoided at all times. A clear stack is not a sign of proper combustion for it may mean an excessive amount of air is being taken into the firebox.

The best combustion is indicated by a slight light-gray haze at the stack.

### SANDING FLUES

36. The locomotive should be well sanded when starting on trip, selecting a suitable point with view of avoiding smoke nuisance. During this process, engineman will watch the stack, note the change in color and instruct the fireman as the black smoke diminishes. Keep on sanding as long as black smoke follows each application. Use small scoop provided for that purpose. The amount of sand necessary to clean flues varies with the amount of soot present and also with the manner in which it adheres to the flues.

Sanding should never be done when engineman is not on the lookout ahead, within city



limits, or while passing any side track, or over switches. Sanding must not be done near bridges, cotton platforms or buildings or when it is likely to cause any annoyance to the public. After a reasonable application of sand, it will be noted that the amount of escaping black smoke is considerably less. During the first two or three miles the occasional repetition of this sanding process will loosen up considerable more soot, which was present but did not come off with the first sanding. The sanding must be repeated until, by the absence of smoke at the stack, the flues are known to be reasonably clean. In the process of sanding, the locomotive must be worked hard enough to draw the sand through the flues. Firemen will use no more sand than is necessary to clean the flues.

Sanding should also be done just prior to entering points where locomotive is to be put in roundhouse or otherwise detained, in order to have flues clean when firing up again. Atomizer should be slightly reduced and firing valve slightly closed when sanding; also dampers partly closed, that all gases may be carried through flues and out of stack.

### **DRUMMING**

37. The drumming of a locomotive may be due to faulty condition of the brickwork, careless handling of the firing valve, the atomizer or improper damper opening. The disturbance may be taken as a warning that too much oil or steam is being allowed to pass from the burner. The usual cause for drumming is the misuse of the atomizer, or locomotive not properly drafted.

### **PUTTING OUT FIRE**

38. In putting out the fire, first shut off the oil valve on tender. After the oil in pipes

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between this valve and the burner has been allowed to flow out and burn:

Close the firing valve.

Close the atomizer.

Close the air pump throttle.

Close the front and back dampers.

Enginemen leaving locomotive at point where no hostler or watchman is located, will put out the fire as outlined above.

### **FILLING TENDER OIL TANK**

39. It should always be borne in mind that fuel oil gives off gas that is highly explosive when mixed with proper amount of air; it must also be remembered that the rate of giving off gas increases with temperature of oil. In escaping, this gas fills the surrounding air with explosive mixture, which will explode and flash back into the tank. For that reason a lighted torch or lantern should never be brought nearer than ten feet to ventpipe, oil tank manhole or measuring rod opening.

To avoid overflowing oil tank never fill above marker bar located in manhole strainer. This will allow sufficient room for expansion when heater is applied.

When taking oil and after valve to the spout has been closed, allow the spout to drain before moving from the manhole, to prevent oil from being spilled on top of tank which is hazardous to enginemen and trainmen while walking over top of tank. The top of oil tank should be free from oil at all times. The manhole should be clamped down tightly and under no condition should it be left open, except when tank is being filled with oil.

### **MEASURING OIL**

40. Attention should be given to accurate measurements, and instructions relative thereto should be fully complied with.

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To measure the oil, pull up the measuring rod, and wipe oil off at the top. When wiping rod see that threads of waste do not adhere to it as they will finally reach the valves, clog them, and interfere with oil distribution. Do not allow waste to collect on top of oil tank, as it may be blown into the oil.

## FIRING LOCOMOTIVES

41. The firing of an oil-burning locomotive differs very materially from the firing of a coal-burning locomotive and more careful attention is necessary in burning oil than coal to render economical combustion. While the firing of an oil burner does not require any great physical exertion, it demands that close attention be given it at all times to produce satisfactory results. To this end the engineman and fireman must work together. The fireman should observe the movements of the engineman, maintaining as closely as possible the maximum steam pressure; also, an even water level. For the fireman to accomplish this, he must not wait until notified by the engineman to operate the oil valve but every time the engineman changes the throttle or reverse lever, the fireman should regulate the fire. The atomizer must be adjusted as the oil feed increases. Under no circumstances admit more oil than the air supply will burn. Whenever black smoke forms, oil is being wasted. In regulating the air supply that is needed for complete combustion, admit enough air to consume all of the smoke but do not go to the other extreme admitting more air than is needed to consume the smoke.

The best method of adjusting the draft is by increasing the air supply gradually until the color of the fire in fire box becomes clear.

It is advisable at first to have a very moderate draft; then, by close observation, build up the fire by gradually increasing the oil feed, atomizer opening and air supply, until the desired fire is produced.

A smoky flame denotes insufficient air and imperfect combustion. An excess of air results in cooling the hot gases, which is wasteful, because the heat is being carried off by the excess air.

## 42. Principle on which injectors work:—

The action of the injector is due first to the difference between "kinetic" or moving energy and "static" or standing energy; second, to the fact that steam at a pressure travels at a very high velocity and when placed in contact with a stream of water it is condensed into water, and at the same time it imparts enough velocity to the water to give it sufficient momentum to overcome a pressure even greater than the original pressure of the steam. By imparting this velocity to the water it gives it sufficient energy to throw open the check valves and enter the boiler against high pressure. An injector consists of a body supplied with a steam valve, a steam nozzle, a primer, a combining tube, a delivery tube, a line check valve, an overflow valve, a water valve; a lifting injector has a lifting tube.

Difference between lifting and non-lifting injector:—

A lifting injector will create sufficient vacuum to raise the water from the level of the tank. The steam tubes in a non-lifting injector are different and will not raise the water, but merely force it into the boiler. A non-lifting injector must be placed below the level of the water in the tank so that the water will flow to it by gravity.



A lifting injector will not work with a bad leak between the injector and the tank—it will not prime because the air admitted through the leak destroys the vacuum necessary to raise the water to the injector level. A non-lifting injector will work, as the water will escape from the pipe instead of air being drawn into it as with lifting injector.

If an injector primes well, but breaks when the steam is turned on full, the trouble is due to insufficient water supply, tank valve partly closed, strainer stopped up or tank hose kinked, injector tubes out of line, lined up, delivery tube cut-out or wet steam from the throttle. If an injector will not prime, trouble is due to insufficient water supply, priming tube out of order, or with the lifting injector the trouble might be caused by leak between the injector and tank.

An injector will not prime if the injector throttle leaks badly or if the boiler check leaks badly or is stuck up.

If steam or water shows at the overflow pipe when the injector is not working you can determine whether it is the boiler check or injector throttle by closing the main steam valve at the boiler; this will stop the leak if it comes from the injector throttle. An injector will prime if primer valve leaks, but may waste some water from the overflow.

To prevent injector feed pipes or tank hose from freezing in winter when not in use, steam valve should be slightly opened to permit a slight circulation of steam through the feed and branch pipes.

The heater cock should be closed and the drip cock under the boiler check or on the branch pipe should be opened to insure a circulation of steam through the branch pipe.

43. Method of operating locomotive Momi-tor lifting injectors as shown in Figure 3:

To start: Open valve W; then open valve J. When water appears at the overflow, open valve S until overflow ceases, then close valve J. Do not increase steam supply after overflow has ceased.

To stop: Close valves S and W.

To blow back injector or to apply heater, close valve H and open valve S; but the valve H should never be closed except when the injector is to be used as a heater. Regulate quantity of water needed by valve W. To cut down the injector, throttle water by valve W. If this is not sufficient, reduce the quantity of steam supplied.

44. Method of operating locomotive lifting injectors Simplex Type, shown in Figure 4:

To start: Open water valve A; then pull out lever B. Regulate quantity of water needed by valve A. To use as heater from the feed water, close cock C and pull out lever B.

To stop: Push in lever B. In operating lever B it should be handled gently, never pull or close same with a bang. When injector is in operation should water continue to flow out the overflow it is generally caused by the water inlet valve leaking and prevents the prompt lifting of the feed water; it will only be necessary to turn around key D, so that the letter "S" on the square spindle end will be up. This will permit the continued use of the instrument, until inlet valve can be repaired. Upon arrival at roundhouse this should be reported.

45. Method of operating 1918 Special "A" and "B" non-lifting injectors as shown in Figure 5:

To start: Open water valve W; then open overflow valve O. When water appears at

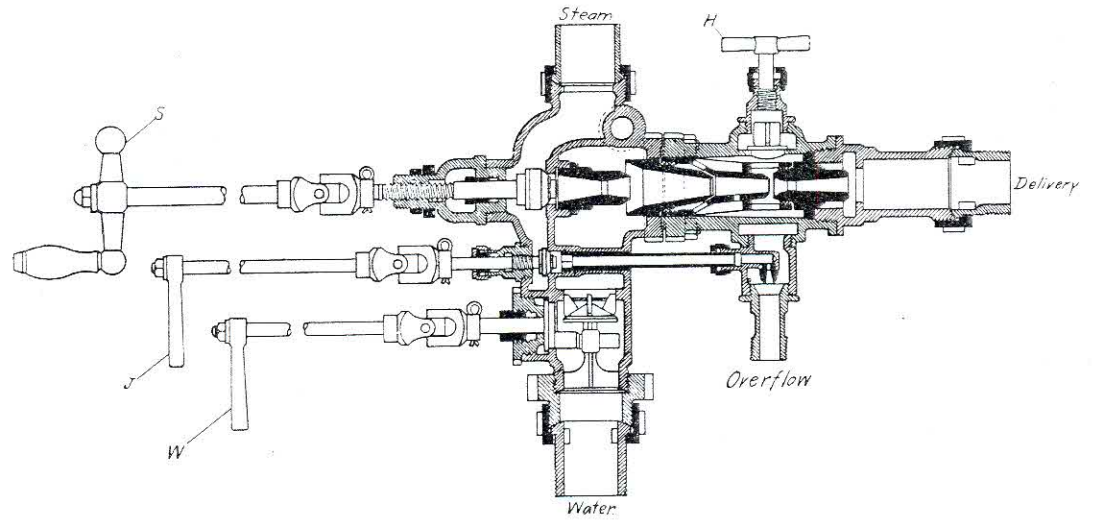


Fig. 3.

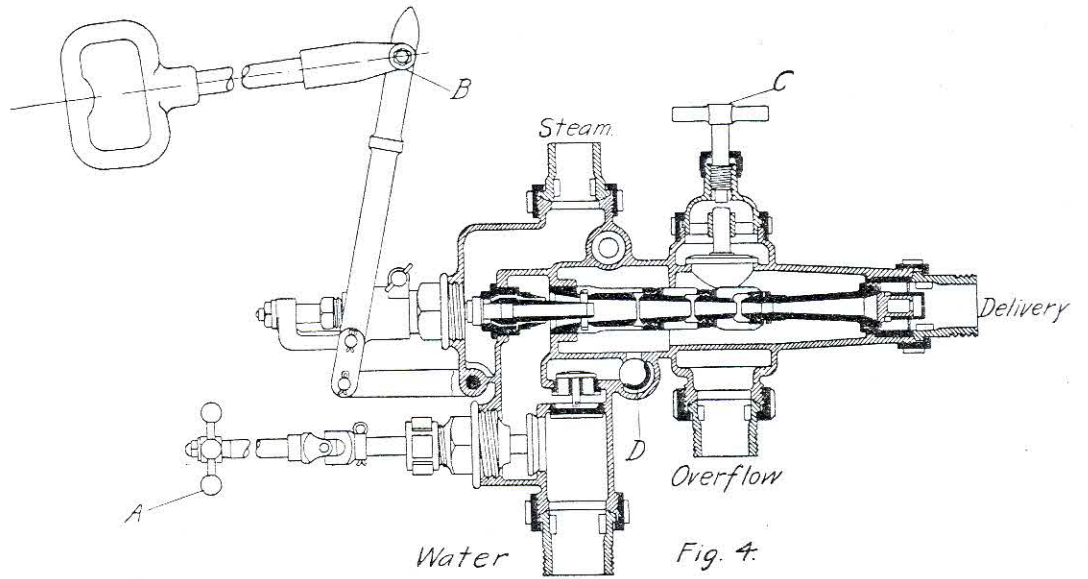


Fig. 4.



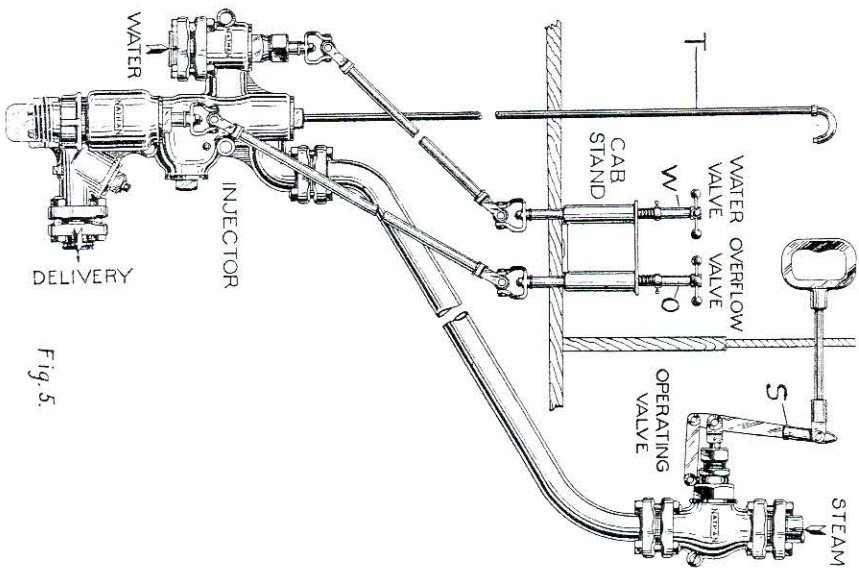


Fig. 5.

overflow, pull out operating valve lever S to its full extent.

To stop: Push in lever S and close either the overflow valve O or the water valve W. In shutting off injector while on the road, it is preferable to close overflow valve, thus avoiding disturbing adjustment of water valve controlling water supply. Quantity of water needed is regulated by water valve W.

To blow back injector or to apply heater, close overflow valve O, open water valve W, and slightly pull out operating valve lever S.

If the feed water is warmer than the injector will take up without spill at the overflow, overflow valve O must be closed after the injector has been started.

When injector breaks, steam will blow through tell-tale nozzle T in cab. If injector does not start again automatically, push in lever S and start over.

### FEED WATER HEATERS

46. The purpose of the feed water heater is to reclaim the heat in a portion of the exhaust steam that otherwise would be wasted at the stack and return it to the boiler in the feed water, thus reclaiming a large amount of waste heat and reducing the amount of heat required in the furnace to raise the temperature of the water in the boiler to that of the steam at the prevailing boiler pressure.

The proper use of feed water heaters insures a fuel saving of from 10 to 20 percent, depending on operating conditions. This saving is due to the fact that less fuel is required to convert hot water into steam and in part to the increased efficiency of the boiler because it has less work to do when part of the heating of the water is accomplished in the heater. Due to the fact that the waste steam

is condensed and used again in the boiler feed water, the heater also has the effect of increasing the effective water tank capacity from 12 to 15 percent.

### FEEDING WATER TO BOILERS

47. In supplying water to boiler, a small quantity at a time (not over one inch in glass) should be fed when locomotive is not working, as circulation is not active and as the water delivered to the boiler is comparatively low in temperature, it settles to the bottom, causing contraction resulting in boiler leaking.

The best results will be obtained while engine is working by feeding the boiler to maintain an even water level at all times; it is also important to maintain an even steam pressure.

Irregularity in supplying water to boiler, also allowing steam pressure to vary, causes contraction and expansion of flues and sheets which result in leaky boiler. The steam pressure should not be allowed to vary more than five pounds from the maximum.

Great care must be taken on approaching the top of a hill or station, where it is expected the locomotive will be shut off, to gradually slow down so that the water in the boiler may be increased to a point where injector can be immediately shut off when the throttle is closed. Starting out of a station with the injector working will materially reduce the steam pressure.

On locomotives equipped with feed water heaters the pump should not be used to supply the boilers when engine is not working steam as there is no available exhaust steam flowing to heater to heat the water. The pump should be started immediately

with the opening of the locomotive throttle and regulated to maintain an even water level in boiler at all times and to have sufficient water in boiler approaching stations and on approaching top of hills where it is expected that locomotive throttle will be closed. In event more water is wanted the injector should be used to maintain water level.

### LOCATION OF OIL BURNING EQUIPMENT

48. The various cab valves, tank fittings, and other oil burning equipment shown in Figures 6 and 7, are as follows:

- No. 1—Blower Valve.
- No. 2—Atomizer Valve.
- No. 3—Tank Oil Heater Valve.
- No. 4—Blow-back Valve.
- No. 5—Oil Regulator.
- No. 6—Oil Feed Cock.
- No. 7—Engine Oil Heater Valve.
- No. 8—Oil Heater Drain.
- No. 9—Check Valve.
- No. 10—Oil Heater Pipe.

### ROUNDHOUSE INSPECTION OF LOCOMOTIVES

49. On arrival of locomotives at engine house, thorough inspection of firebox, firepan, and firing apparatus, should be made. The firepan must be free from any obstruction of brick or carbon accumulation.

See that joints between the firepan and the firebox are absolutely air tight. Air leaks at these points produce bad results. The oil and steam channels of oil burner should be thoroughly cleaned out, using a saw blade for this purpose.

Smoke-boxes should be absolutely air tight and should be examined each trip, together



### Oil Piping Arrangement for Firepan with Vertical Draft

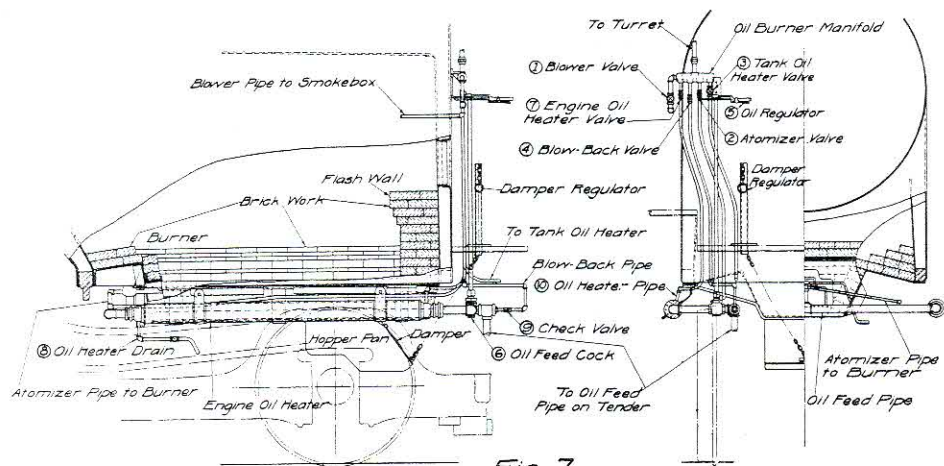


Fig. 7

with front end steam pipes and petticoat pipes. Baffles to be in good condition and properly adjusted.

Flame from burner should strike flash wall in center, and not strike floor of firepan before striking flash wall. Draft openings in bottom of fire pans should be cleaned out thoroughly each trip. No lost motion should be allowed in firing device. Sand for sanding flues should be fine in size, thoroughly screened, dry and free from foreign materials.

After each round trip, or if necessary after each trip, flues must be tested with a torch to see that they are opened from end to end by holding torch to the flue. If open, the draft will deflect flame into flue. Flues must be maintained in clean condition and not allowed to go out stopped up. When flues are stopped up they should be bored out with augers and then blown out thoroughly with air or steam.

#### **PUTTING LOCOMOTIVE IN ROUNDHOUSE**

50. Hostlers will be held strictly responsible for condition of all locomotives at the time they leave them at the roundhouse or designated track. They must be left with throttle closed tightly, reverse lever in center position, cylinder cocks open, blocks under wheels, dampers and firedoor closed tightly. Firing valve, oil tank valve, blower, atomizer, heaters, compressors, dynamo, lubricator, steam valves and injectors closed, unless engine is left under steam in charge of engine watchman.

#### **WHEN PLACING ENGINE ON YARD TRACK**

51. It must be left in position to give the required clearance to adjacent tracks.

**Foremen in the course of their duties must keep these points closely under their observation.**

#### **APPLYING BRICKWORK**

52. In applying brickwork for lining fire-box and fire pans use fire clay or molding sand, stirred with water to the consistency of a thin paste. The bricks should be placed as closely together as possible. Large quantities of lining mixture should not be used at any one point or depended upon entirely as a fire resisting surface. After the brick setting has been completed, all exposed surfaces are coated with a solution of soda ash and water, mixed until it will flow freely. This makes a very satisfactory glaze and a fire resisting surface. Under no circumstances should brick work be cooled by pouring water over it.

Other lining and glazing materials approved by Superintendent Motive Power, may also be used.

#### **METHOD OF CLEANING OIL TANKS OF TENDERS PREPARATORY TO MAKING REPAIRS**

53. The tank should first be drained, man-hole cover removed, and sufficient time allowed for tank to thoroughly drain and ventilate. If the oil is thick, or repairs are being made in cold weather, steam should be admitted to heat the tank and oil so that the draining of the tank may be facilitated. While tank is being steamed out some old sacking may be thrown over manhole opening so as to confine the steam; at the same time there